1994

CONSTRUCTION OF BREAKWATERS AND BEACHFILL AT THE NAVAL AIR STATION, PATUXENT RIVER, MARYLAND

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ABSTRACT

Construction of the breakwaters and beach fill for beach erosion control commenced in October, 1993 and was completed in January, 1994. The project site is located on the northwestern shoreline of the Naval Air Station, on the Patuxent River entrance to Chesapeake Bay. To protect the 1,000 foot shoreline fronting an abandoned landfill, a 260 foot shore-connected breakwater and five discrete offshore breakwaters, with lengths ranging from 70 feet to 130 feet and crest elevations of +6.5 feet MLW, were constructed to contain approximately 25,000 cubic yards of new beach fill. This paper provides detailed information on the construction procedures and techniques for the shore-connected and offshore breakwaters and beach fill, and provides a brief discussion of the advantages of this type of shore protection system.

INTRODUCTION

Beach nourishment and shoreline erosion control using offshore segmented breakwaters and beach fill is relatively new in design and construction. Most of the documented design and construction are in the Great Lakes region and the Chesapeake Bay area as reported by Thomas Bender (1992), Edward Fulford & Kenneth Usab (1992) and Coastal Design & Construction, Inc. The offshore breakwater and beach fill projects have been successful in beach erosion control and in creating recreational beaches. In general, this system is more effective in a partially sheltered environment without direct ocean wave attack.

The design of this project was carried out by Andrews, Miller & Associates, Inc. of Cambridge, Maryland. Construction of this project was performed by

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Coastal Design and Construction of Gloucester, Virginia. Frederic R. Harris was the Title II Engineer responsible for the construction inspection of this project. This paper emphasizes the construction procedures and techniques for the segmented offshore breakwaters and beach fill. A brief discussion is presented to compare this type of shore protection with the conventional beach fill/annual maintenance and beach fill/groin system.

SITE CONDITIONS

The construction site at Fishing Point on the Naval Air Station is located at the west side of Chesapeake Bay, near the entrance of Patuxent River and west of Hog Point Inlet as shown in Figure 1. The shoreline is approximately 1,000 feet in length with a narrow sandy beach backed by a bluff rising to a plateau of elevation 6 to 7 feet MLW (Figure 2). Due to the direct exposure to storm waves from Chesapeake Bay, this section of shoreline is subject to constant erosion. Since the shoreline protects an abandoned landfill, the site was in need of immediate shore protection. The net longshore sediment transport is east to west with littoral material carried into deeper parts of the river.

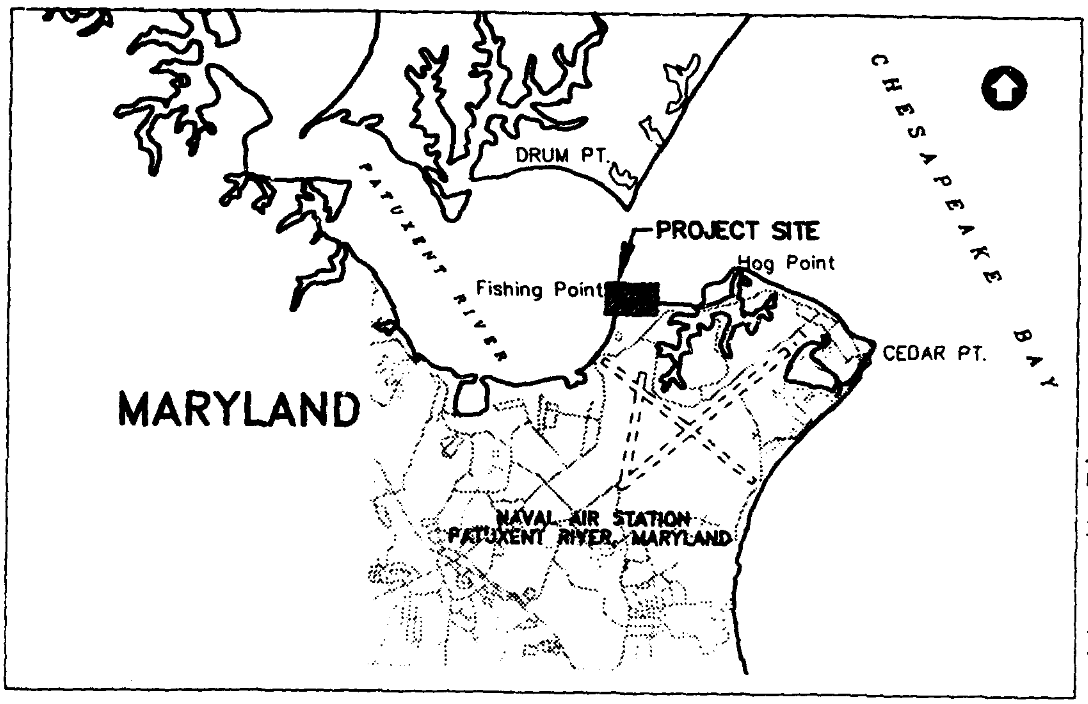

Figure 1 Project Location

Water depths at the breakwater site range from 3 to 5 feet below mean low water. Based on the results of boring investigations, the subbottom material is mostly compact sand. Based on a 100-year design condition, the design wave at the site would be at a height of 7 feet, breaking at the breakwater. The 100 year storm surge level is approximately +6 feet Mean Low Water. The mean tide range at the site is 1.2 ft and the average maximum tidal current is on the order of 0.5 knot.

Figure 2 Existing Shoreline

PROJECT DESIGN

The project includes a 260' shore connected rubblemound breakwater and five discrete offshore breakwaters approximately 200' from the existing shoreline and 120' from the berm crest of the new beach fill as illustrated in Figure 3.

The typical cross section of the breakwater, shown in Figure 4, includes an 8.5 ft crest width at elevation +6.5 ft Mean Lower Low Water, side slopes of 1 V on 2 H at bayside and 1 V on 1.5 H at landside, and 6 foot wide toe on both sides. The shore connected breakwater has a 9 foot wide toe from Station 1+00 to 2+65. The armor is graded granite quarry stone ranging in weight from 2,700 lb to 4,500 lb.

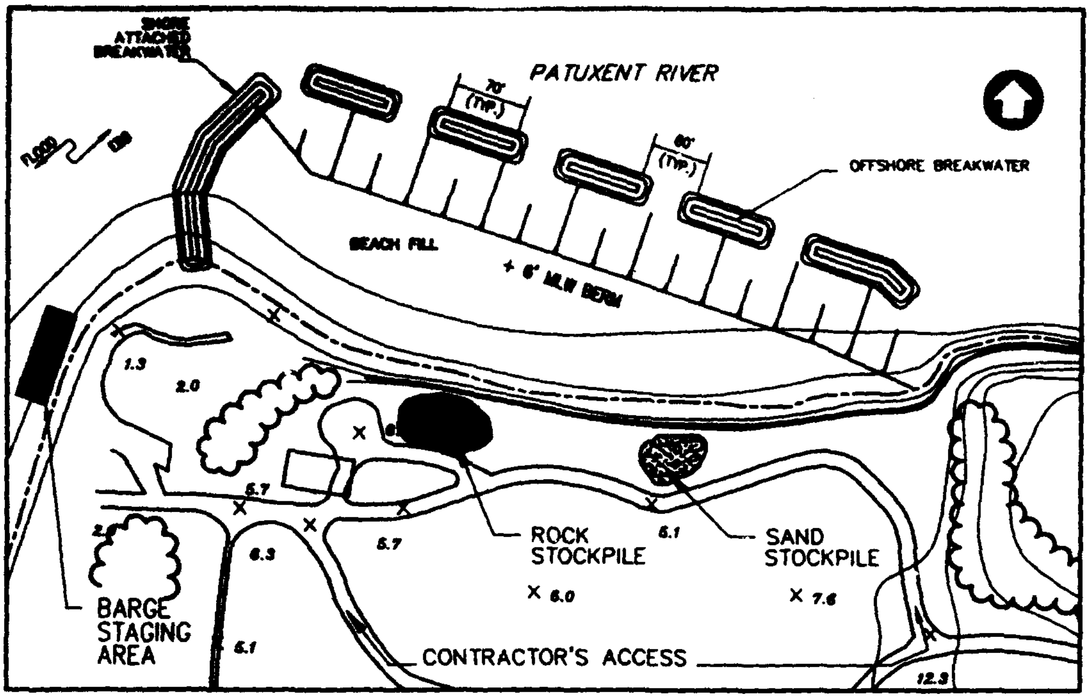

Figure 3 Site Plan

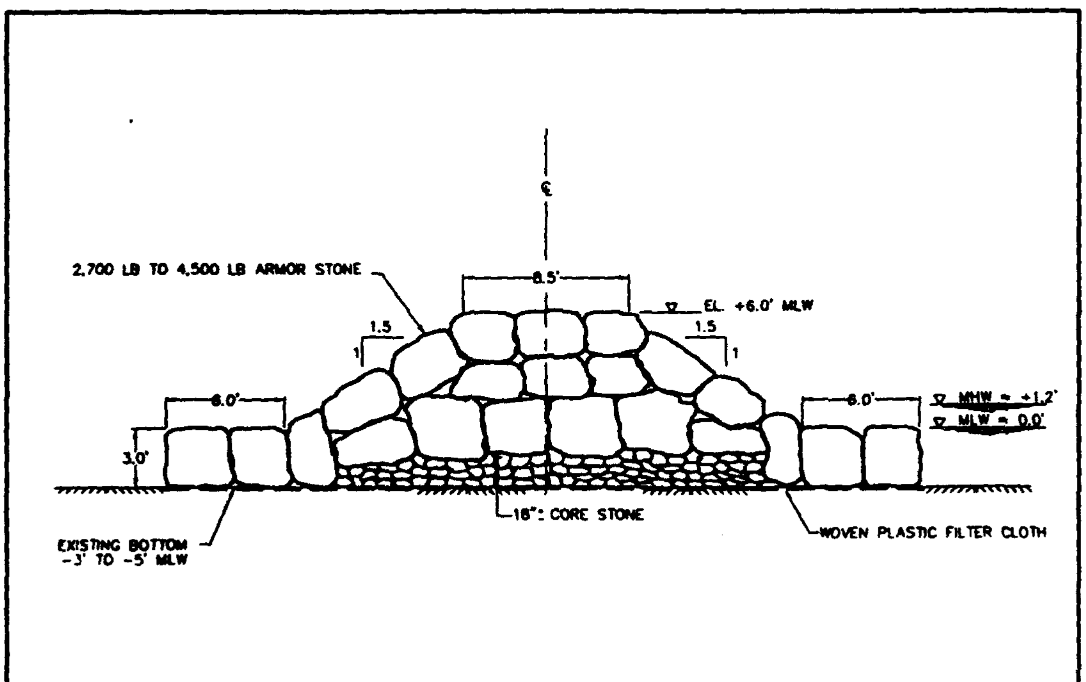

Figure 4 Typical Breakwater Section

The armor was designed to be built on an 18" thick bedding layer resting on filter cloth. Beach fill was to be placed along the shoreline with an 80 ft berm width at elevation +6 ft Mean Lower Low Water and 1 V on 10 H beach profile. The contract plan was prepared by Andrews, Miller & Associates, Inc. of Cambridge, Maryland.

CONSTRUCTION

The prime contractor was Coastal Design and Construction, Inc. of Gloucester, Virginia. The duration of construction was approximately four months, from October 1993 to January, 1994. Construction activities included mobilization of equipment, preparation of the service road and staging areas, stockpiling of armor stone, core stone and sand, construction of the breakwaters, beach fill placement, restoration of disturbed areas, and demobilization. A construction schedule is shown in Figure 5.

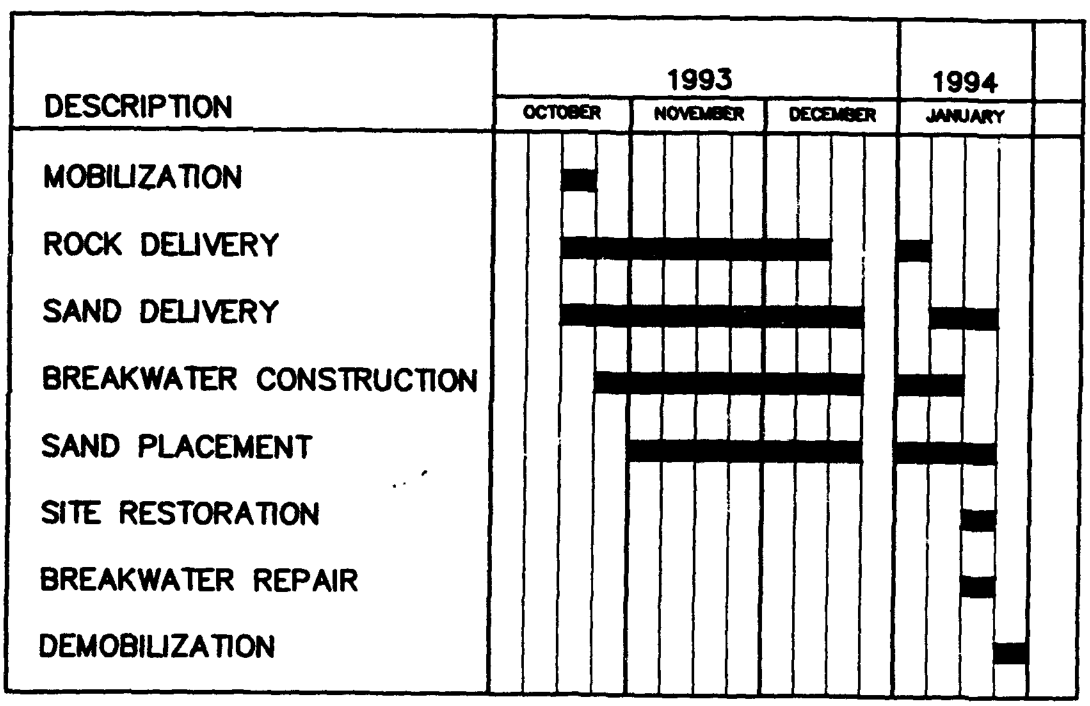

Figure 5 Construction Schedule

Material

Major construction material for this project included approximately 12,000 tons of armor rock, 4,000 tons of core stone and 25,000 cubic yards of sand. The rock materials were delivered via barge from the quarry source located at Havre de Grace, Maryland (on the Susquehanna River), approximately 90 miles north of the site. The barges, containing approximately 550 ton of armor rock per load, were unloaded by a barge-mounted crane equipped with a clamshell bucket into Volvo Penta A20 dump trucks and transported to the stockpile (Figures 6, 7).

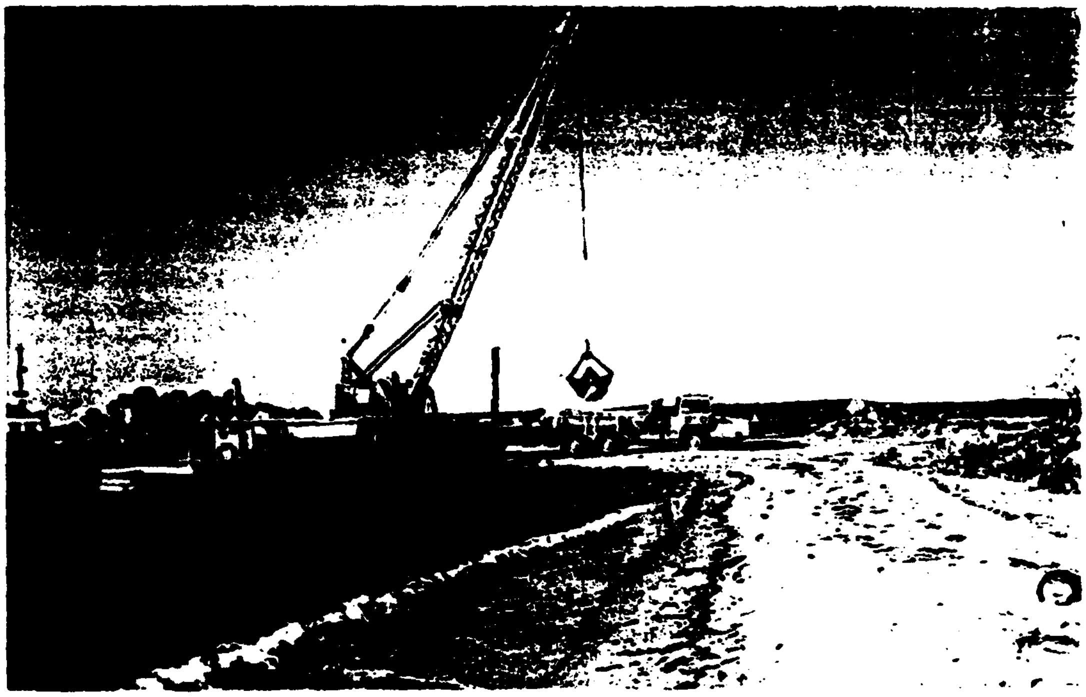

Figure 6 Unloading Stone Barge

Figure 7 Rock Stockpile

At the stockpile, the contractor used a smaller backhoe equipped with a grapple to segregate smaller stones from the pile. The contractor endeavored to use the largest stones on the breakwater toes and armor layers. However, stones with weights less than 2,700 lbs. were inevitably placed in the armor layers to facilitate breakwater construction, since the project was conducted in the winter and time was of the essence. The small stones were removed and replaced with larger stones upon completion of initial construction of the breakwaters.

The beach fill material was delivered via 12 cubic yard dump truck or 36 cubic yard truck trailer from the sand pit located 5 to 6 miles from the construction site. Approximately 2,000 truck loads were delivered to the site via the service road and stored at several temporary piles. The sand was spread on beach with using front end loaders and bulldozers (Figure 8).

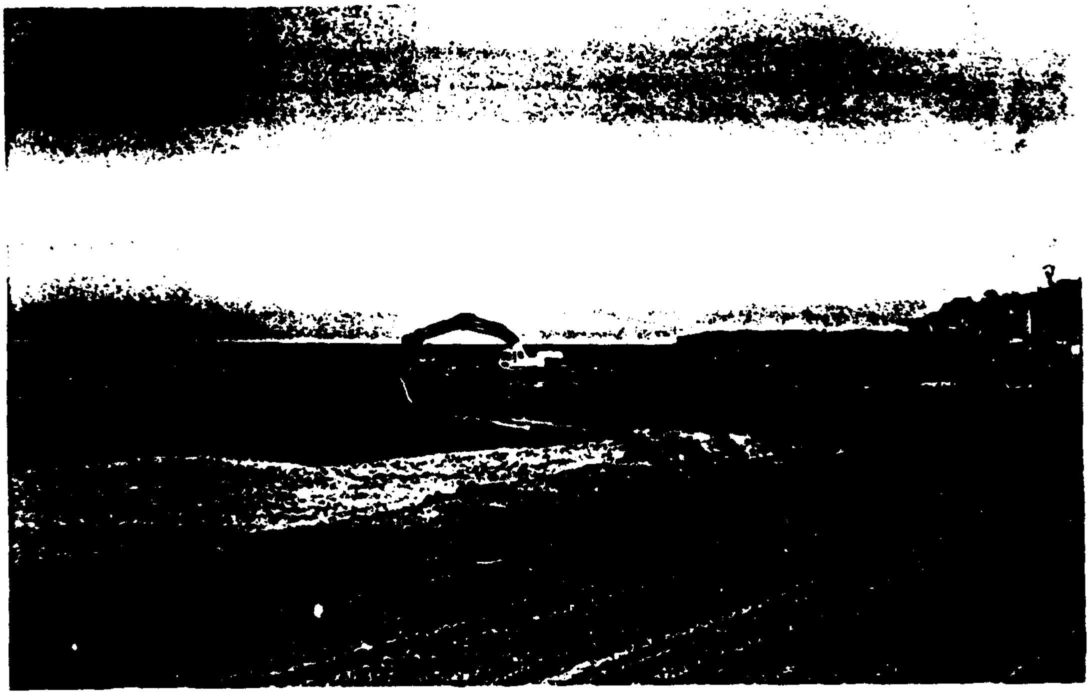

Figure 8 Spreading Beach Fill

<u>Breakwaters</u>

The single shore-connected and five segmented breakwaters were constructed using land-based equipment including a Link Belt LS 5800 backhoe for stone placement, a Caterpillar front end loader for stone transport, and a Link Belt backhoe with gripple for loading stone. To reach the offshore breakwater sites, temporary causeways were built using the sand fill material from the existing shoreline to the breakwater sites (Figure 9).

The foundation of the breakwater was prepared by placing geotextile fabric on the existing sandy bottom, anchored by armor units around the toe. Core stone was placed on top of the filter fabric to a thickness of 36", a change suggested by the contractor and approved by the designer. The armor and core stones were transported to the breakwater site from the armor stockpile via the front end loader. The rock was dumped into a steel containment bin located at the end of causeway, then picked up and set in place with the backhoe. The armor stone was manipulated in place and compacted to leave minimum voids and maximum contact between each armor unit (Figure 10). The final rubblemound slopes, crest widths, elevations and lengths were checked by topographic surveys performed by both the Contractor and Frederic R. Harris, Inc.

Figure 9 Temporary Causeway

Figure 10 Armor Placement

Beach Fill

Final beach fill placement and grading operations were conducted after all six breakwaters were in place. The berm was filled to +6 feet MLW to a crest line approximately 121 feet leeward from the centerline of the offshore breakwaters and maintaining a 1 vertical on 10 horizontal beach slope. Filter fabric was placed against the leeward slope and toe of the shore connected breakwater to prevent seepage of sand thrugh the voids. Immediately after the beach fill was placed, a salient formation of the shoreline was observed. Figure 11 and 12 illustrates the post-construction conditions.

CONCLUSIONS

A growing trend of shoreline erosion control based on the combined offshore segment breakwaters and beach fill has been applied to the Chesapeake Bay and tributary shorelines with successful results. This shore protection system proves to be simple in construction and relatively economical. A typical offshore rubblemound breakwater plus beach fill costs approximately $1,000 per lineal foot of beach. There would be further savings due to reduced renourishment needs.

Compared with other erosion control structures, a shore protection system such as this offers the following advantages:

- Maintaining the littoral transport which is cut-off with groin field construction.
- Creates and retains a recreational beach with easy access, where construction of a seawall reduces the use of a recreational beach.
- Substantially reduces beach nourishment requirements compared to simple beach fill without structural protection.

Despite these advantages, this shore protection system has not been proven effective or economical on the ocean coastlines.

Figure 11 Completed Shoreline Looking West

Figure 12 Completed Shoreline Looking East

REFERENCES

Bender, T., 1992, "An Review of the Segmented Offshore/Headland Breakwater Projects Constructed by the Buffalo District", Proceedings, Coastal Engineering Practice '92, Long Beach, California, March 9-11, American Society of Civil Engineers, pp170-188.

Fulford, E., and Usab, K., "Bay Ridge, Anne Arundel County, Maryland, Offshore Breakwater and Beach Fill Design", Proceedings, Coastal Engineering Practice '92, Long Beach, California, March 9-11, American Society of Civil Engineers, pp205-220.

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